CHAPTER 3

ELECTRONICS SAFETY

LEARNING OBJECTIVES

Upon completing this chapter, you should be able to do the following:

1. Describe electric shock and its effects on the human body.
2. Describe the procedures to follow for measuring voltages.
3. Describe electromagnetic radiation hazards.
4. Describe the tag-out bill and its responsibilities and procedures.

INTRODUCTION

Electronics safety is essential for the well-being of every Fire Controlman. If you, as a technician, are not thoroughly familiar with electronics safety, you may become the next casualty.

To be an effective Fire Controlman, you must be thoroughly familiar with all aspects of electronic safety. Statistics show that a high percentage of accidents and casualties could have been prevented if some specific precautionary measures had been taken. Common sense, good indoctrination, and training are required of all personnel maintaining and operating electronic equipment.

When working with electronic equipment, you should remember this rule: **SAFETY FIRST**. Dangerous voltages energize much of the equipment you work with.

Use the safety precautions outlined in this chapter to complement information given in your electronic equipment instructions. These instructions (applicable directives and equipment technical manuals) provide specific safety instructions. Before you perform maintenance on any equipment, be sure to observe all required safety precautions.

This topic discusses electric shock, voltage measurement, electromagnetic radiation hazards, tagout bills, and protective equipment.

ELECTRIC SHOCK

Electric shock is the sensation and muscular spasm caused when electric current passes through the body. The word *current* is underlined in the last sentence to emphasize that it is the *current* and NOT the voltage that causes electric shock. No matter how much voltage is present, you will be shocked only if you provide a ground path for the electric current.

The following excerpt from a mishap report shows just one result of not following proper safety procedures:

"While trying to adjust the alignment between coarse and fine synchros in the gun drive drawer, a Fire Controlman received a shock from a 115-volt source. While performing preventive maintenance, he discovered that the alignment did not meet the performance specifications required by the maintenance requirement card (MRC). After trying to align the synchros, he discovered that the fine synchro was faulty. To get into the synchro control box, he removed the insulation cover. While adjusting the synchro, the technician touched the exposed wiring on the synchro with his thumb, allowing 115 volts of alternating current to enter his thumb and forearm. He went to medical, after which the corpsman sent him to the naval hospital for evaluation and observation. He was released the next day, slightly damaged, but very much aware of the value of following safety procedures."

Ninety-nine percent of what you do in your job as a Fire Controlman , you will do around electricity. Since that makes you extremely susceptible to electric shock, it's very important for you to know the basics of electric shock, how to avoid being shocked, and how to treat victims of electric shock. The following section discusses those factors.

This section discusses the severity, avoidance, and victims of electric shock.

BASICS OF ELECTRIC SHOCK

The following factors determine the severity of the effect electric shock has on your body:

- The amount of body resistance you have to the current flow.
- The path the current takes through your body.
- The length of time the current flows through your body.

Body Resistance

Resistance varies greatly in different parts of your body. A value of 1,500 ohms is commonly used as the resistance between major extremities of an average human body: hand to hand, or hand to foot.

For example, suppose you accidentally grabbed a wire carrying 120 volts alternating current (V ac). We can use Ohm's law, I = E/R, to figure how much current would flow through your body:

E = 120 V ac (the voltage you grabbed)

R = 1,500 ohms (your average body resistance)

Therefore:

I = 120/1,500 amp
I = .080 amp
I = 80 milliamperes

Therefore, if you grabbed a 120-V-ac wire, 80 milliamperes of current would flow through your body!

Table 3-1 shows the effects of varying amounts of electric shock on a normal person. In our example, you grabbed 80 milliamperes of current! That is 15 milliamperes beyond what could be fatal. It is also 70 milliamperes beyond the "can't-let-go" threshold for a 120-pound person and 62 milliamperes beyond what is needed to cause you to stop breathing.

Table 3-1.—Effects of Electric Shock

CURRENT (milliamperes)	HUMAN REACTION (at 60 Hertz)
1.1	PERCEPTION: A slight tingling sensation.
	CAN'T LET GO: Arm and hand muscles close involuntarily:
10.0	A 120-pound person.
16.0	A 175-pound person.
18.0	CAN'T BREATHE: PARALYSIS OF THE CHEST MUSCLES.
65.0	HEART FIBRILLATION: Rapid, irregular contractions of the heart muscles. Could be fatal.

Remember, the 1,500 ohms is just an average value. Body resistance varies from person to person and may often be less than 1,500 ohms. When your skin is moist, your body resistance could be as low as 300 ohms! Also, breaks in your skin at the point of contact could reduce your skin resistance to nearly zero!

Skin resistance is only important when you are handling voltages of less than 240 volts. If you get shocked by more than 240 volts, the voltage arc will burn through your skin and leave deep, third-degree burns where it enters your body.

Current Flow Path

The two most dangerous paths that current can take through your body are (1) from hand to hand and (2) from left hand to either foot. The second path is the MOST dangerous since the current will flow through both your heart and other vital organs.

Current Flow Duration

Fibrillation is the shocking of your heart into a useless flutter. The longer you are shocked, the more chance there is for your heart to begin fibrillating. Most people who die from electric shock die from fibrillation. Fibrillation in a normal adult is unlikely if the current in milliamperes is less than 116/t, where "t" is the shock duration in seconds. The longer you are shocked, the less current is needed to cause heart fibrillation.

Some examples of shock current levels and durations that could cause fibrillation are:

- 21 milliamperes for 30 seconds,
- 44 milliamperes for 7 seconds, or
- 67 milliamperes for 3 seconds.

HOW TO AVOID BEING SHOCKED

Preventing yourself from receiving an electric shock can be summed up in three words: isolate, insulate, and ground.

1. **Isolate**: Isolate yourself from the source of electric shock. Secure the power to equipment before you attempt to work on it. Be sure to keep all electrical equipment covers, doors, and enclosures in place when you are not actually working on the equipment. If you must leave circuitry exposed, rope off the area, post appropriate signs, and warn your fellow workers of the danger.
2. **Insulate**: Make sure that the electrical tools and equipment you use are properly insulated. Use only approved insulated hand and portable electric power tools. Check power and extension cords frequently for deterioration, cracks, or breaks. Breaks in the insulation cause many electrical mishaps.
3. **Ground**: Electric current always follows the path of least resistance. To prevent yourself from being the unintentional path to ground, make sure that your equipment is well grounded. Well-grounded equipment will direct any stray electric current to ground, thereby protecting you from electric shock. A good ground can also help protect your equipment from excessive voltage spikes or lightning. For further information on equipment grounding, see *Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety,* MIL-STD 1310 (NAVY).

HOW TO TREAT VICTIMS OF ELECTRIC SHOCK

The rescue of electric shock victims depends on prompt action. However, to avoid becoming a victim yourself, you must observe the following safety precautions:

1. Shut off the voltage at once.
2. If you cannot shut off the voltage immediately, try to free the victim from the live conductor by using a dry board, belt, or clothing, or other nonconducting material. **Do not make direct contact with any part of the victim's body with any part of your body**! If you do, you will become part of the same circuit and may become an electric shock victim yourself!
3. After you remove the victim from the power source, determine if he or she is breathing. If the victim is not breathing, apply cardiopulmonary resuscitation (CPR) without delay. Loosen the clothing about the victim's neck, chest, and abdomen so that breathing is easier. Once the victim is breathing, protect him or her from exposure to cold, with a warm cover, if possible.
4. Keep the victim from moving. After a strong shock, the heart is very weak. Any sudden effort or activity may result in heart failure.
5. Send for a doctor or a corpsman, and stay with the victim until medical help has arrived. Do not give the victim stimulants.

To be able to successfully rescue a shock victim, it is extremely important that you and your shipmates be qualified in CPR. The effects of electric shock can range from mild surprise to death. It depends on the amount of current, the voltage, and the duration of the electric shock. Since people have varying resistance levels, it is hard to know exactly how a shock victim will be affected. More than likely, the victim will be very pale or bluish in color and may be unconscious. Therefore, immediate action is of the utmost importance.

Q1. What three key factors will determine the severity of electric shock on your body?

Q2. What three one-word commands should you follow to prevent shocking yourself?

VOLTAGE MEASUREMENT

You will be required to work on energized equipment during many of your job assignments. For example, as you troubleshoot a piece of electronic equipment, the technical manual may instruct you to measure voltages or to check signal waveforms while the equipment is energized. If so, before you connect the multimeter or the oscilloscope, there are certain safety precautions and procedures you MUST follow that are designed to protect you from electric shock. These precautions and procedures are divided into two

Table 3-2.—Procedures to Follow When Measuring Voltages Below 300 Volts

Step	Procedure
1	ALWAYS notify and obtain permission from your commanding officer (afloat) or your supervisor (ashore) to work on energized equipment. (Some commands require you to complete a checklist before doing this.)
2	ALWAYS study the schematic and wiring diagrams of the equipment on which you will be working. Note the location of the test points and the location of any other high-voltage points that you should be careful not to touch.
3	ALWAYS remove all metal items, such as, watches, belt buckles, rings (even wedding bands), and other items that have exposed metal. If you are wearing a security badge, put it in your pocket.
4	ALWAYS ensure that you are wearing electrical safety shoes, if they were issued, and that you are standing on insulating rubber matting. If you must insert your hand into the enclosure of the energized equipment, wear electrical safety rubber gloves rated for the appropriate voltage. See table 3-3.
5	NEVER work alone. Have a co-worker stand by. Make sure that your co-worker knows where to secure the power in case of emergency.

basic voltage categories: (1) voltage measurements below 300 volts, and (2) voltage measurements above 300 volts.

VOLTAGES BELOW 300 VOLTS

Most of the voltage measurements that you will make will be below 300 volts. Almost all the newer electronic systems operate at less than 28 volts, except for the main input ac power. Table 3-2 lists the safety procedures for measuring voltages below 300 volts. Follow them!

In addition to the procedures in table 3-2, you must obey the four safety precautions in table 3-4 when you take measurements on energized equipment.

The following excerpt from a mishap report shows the importance of following these precautions:

Table 3-3.—Rubber Glove Ratings

Class	Maximum Safe Voltage
0	750 volts
I	3,000 volts
II	4,000 volts
III	5,000 volts

"A technician could not get the alligator clip on the test lead to stay on the probe, so he held the clip to the probe with his right hand. He violated safety precautions by continuing to hold the clip and the probe while he was energizing the test lead with 1,200 volts. Soon

Table 3-4.—Safety Precautions For Measuring Voltages Below 300 Volts

No.	Safety Precaution
1	ALWAYS use test probes with safety guards or barriers on the probe tips to prevent your hand from inadvertently touching the probe tip.
2	ALWAYS use insulated alligator clips.
3	ALWAYS keep your body clear of any metal parts of the equipment on which you are working.
4	ALWAYS try to keep one hand in your pocket or behind your back when you are taking a measurement to avoid creating a ground path for electric current flow through your body from hand to hand.

thereafter, he touched the ground lead and received a serious shock. He was treated for minor burns on the palm."

VOLTAGES ABOVE 300 VOLTS

All the safety procedures for measuring voltages below 300 volts also apply when you are measuring voltages above 300 volts. However, the big difference when measuring voltages above 300 volts is that you must NOT hold the test probe while the equipment is energized. Instead, you must attach the test probes while the equipment is de-energized. (Refer to table 3-5).

ELECTROSTATIC DISCHARGE PRECAUTIONS

Electrostatic discharge (ESD) can destroy or damage many electronic components, including integrated circuits (ICs) and discrete semiconductor devices. Since certain devices are more susceptible to ESD damage than others, warning symbols, shown in figure 3-1, are now used to identify ESD-sensitive (ESDS) items. The widespread use of integrated circuits led to the development of special training courses in miniature/microminiature (2M) circuit repair.

Certified 2M technicians are trained in procedures for reducing the causes of ESD damage. The procedures are similar for all levels of maintenance. If you are certified in 2M repair, you should follow the protective measures in table 3-6 to help prevent ESD damage. Remember, although many sources of electrostatic charge are of little consequence during most daily activities, they become extremely important when you work with ESD material. If you are not certified in 2M repair, do not attempt to repair any of these circuits.

For further information on handling ESD materials, refer to *Introduction to Microelectronics, Navy Electricity and Electronic Training Series* (NEETS), Module 14, NAVEDTRA 172-14-00-84.

Q3. What is the FIRST step in taking voltage measurements below 300 volts?

Q4. What is the major difference between using a test probe to measure a voltage above 300 volts and using it to measure a voltage of 300 volts or less?

Q5. What dangerous effect to electronic components are EDS precautions designed to reduce or eliminate?

ELECTROMAGNETIC RADIATION HAZARDS

The electromagnetic spectrum encompasses everyday uses from commercial power to medical

Table 3-5.—Safety Precautions For Measuring Voltages Above 300 Volts

No.	Safety Precaution
1	ALWAYS follow all preliminary safety procedures for measuring voltages below 300 volts before beginning your measurement.
2	ALWAYS make sure that the equipment you are working on is de-energized.
3	ALWAYS follow the tag-out procedures.
4	ALWAYS discharge all high-voltage capacitors with a shorting probe.
5	ALWAYS attach the ground probe of the measuring device first.
6	ALWAYS secure the other probe of the measuring device to the test point to be measured.
7	ALWAYS make sure that the measuring device is set up for the voltage level and polarity to be measured.
8	ALWAYS energize the equipment under test, make the measurement, and then de-energize the equipment.

Figure 3-1.—ESD warning symbols.

x-rays as shown in figure 3-2. You will be concerned primarily with radio frequency (RF) and laser hazards.

RADIO-FREQUENCY RADIATION HAZARDS

Radiation from antennas fed by high-powered, radio-frequency (RF) transmitters has the potential to directly injure the soft tissue of personnel who are near the radiating antennas. These injuries result from the tissue being "cooked" in a manner similar to the way food is cooked in a microwave oven. Transmitters aboard ships, on aircraft, and at shore stations are potential sources of harmful radiation.

The sensations caused by exposure to excessive RF radiation vary. You should remain alert in any area in which you may be exposed to RF radiation because, at some frequencies, exposure to excessive levels of RF radiation will not produce a noticeable sensation of pain or discomfort to give warning that injury may be occurring.

Radiated RF energy can also cause indirect injury to personnel by inducing high RF voltage levels in metal objects. If you touch such an object while it contains a high RF voltage, you will likely receive an RF burn. The current will produce heat as it overcomes the resistance of your skin. The effect of the heat may range from warmth to a painful burn.

LASER RADIATION HAZARDS

The word *laser* is the acronym for light amplification by stimulated emission of radiation. A laser is a concentrated beam of optical radiation. As a technology has increased, the use of lasers has increased from industrial and medical purposes to both offensive and defensive military purposes.

Table 3-6.—Electrostatic Discharge Precautions

No.	EDS Precautions
1	ALWAYS ground the workbenches where you will handle ESDS devices.
2	ALWAYS be sure that you are grounded.
3	ALWAYS check packaging and equipment technical manuals for ESD warnings and instructions.
4	ALWAYS ground the electrostatic unit package of an ESDS device or assembly before you open it.
5	ALWAYS minimize the handling of ESDS devices or assemblies.
6	ALWAYS avoid unnecessary physical movement.
7	ALWAYS hold the ESDS device or assembly through its electrostatic-free wrap, if possible, when you remove or replace it in the equipment.
8	ALWAYS touch, with your bare skin, the surface on which an ESDS device or assembly rests for at least 1 second before you pick it up.
9	ALWAYS avoid repairs that require soldering at the equipment level, if possible.
10	ALWAYS ground the leads of test equipment before you energize it and before you probe ESDS items.
11	NEVER permit ESDS devices or assemblies to come in contact with ungrounded materials.
12	Whenever you service ESDS devices, NEVER touch or handle materials that create static charges without repeating the grounding action.

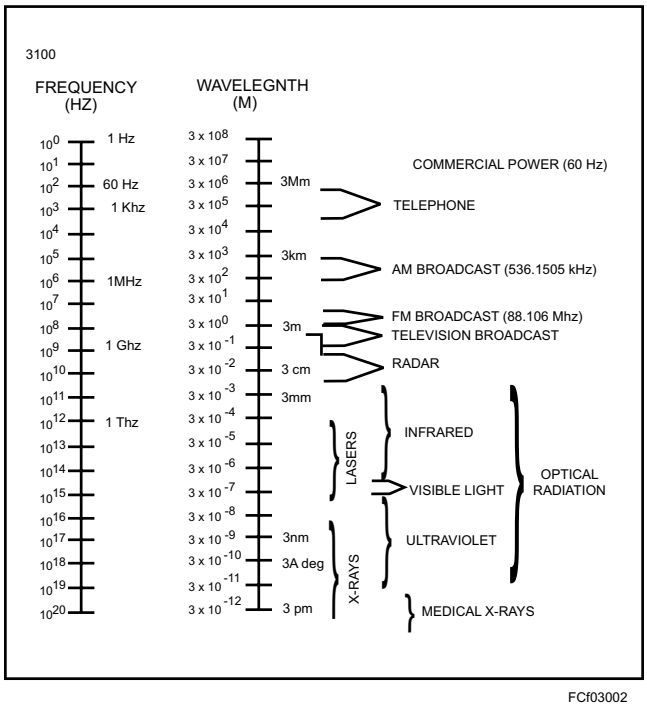


Figure 3-2.—The electromagnetic spectrum.

Lasers can have varying effects on a person. Effects on the eyes can range from inflammation of the cornea to corneal burn. Effects on the skin can range from accelerated skin aging to skin burn. If you use lasers at your command, be sure to follow all safety precautions for the class of laser in use and all directions given to you by your command's laser safety officer.

For more information on the use of lasers, refer to the *Navy Occupational Safety and Health (NAVOSH) Program Manual,* OPNAVINST 5100.23, for shore operations; and the *NAVOSH Program Manual for Forces Afloat,* OPNAVINST 5100.19, for shipboard operations.

Q6. What common household appliance is typically used to illustrate the tissue damage that can be done by harmful RF exposure?

TAG-OUT BILL

The tag-out bill is a system of documents used to save lives and to prevent unnecessary damage to equipment. It uses caution tags, danger tags,

out-of-calibration labels, and out-of-commission labels to let you know when a specific switch, circuit breaker, piece of equipment, electronic system, or plumbing valve should be either operated with extra care or left alone.

It is impossible in this section to identify all situations requiring tag-out procedures. However, we can mention a few situations that require you to tag out certain equipment:

- Working Aloft or Over the Side: When you are working aloft or over the side, be sure that any equipment that could give you radiation burns or that could asphyxiate you is turned off and tagged out.

- Corrective Maintenance: When you are working on equipment that must have its power secured and there is a chance that someone else could inadvertently reapply power while you are still working on the equipment, the equipment should be tagged out.

- Preventive Maintenance: When the PMS MRCs or equipment technical manuals direct you to secure electrical power, those power switches should be tagged out.

TAG-OUT RESPONSIBILITIES

Commanding officers are responsible for the safety of their personnel and the operational readiness of their ship. They are ultimately responsible for ensuring that their personnel follow appropriate tag-out procedures. To help do this, they assign authorizing officers who have the authority to sign, issue, and clear tags and labels. There is usually one authorizing officer for each department, who may be a commissioned officer, a chief petty officer, or a petty officer.

Your department's authorizing officer normally has the following responsibilities:

- Ensure that personnel are qualified to do the work they are about to do,

- Maintain tag-out logs,

- Sign and issue tags and tag-out record sheets, and

- Clear the record sheets from the tag-out logs and destroy the tags when the work is completed.

TAG-OUT DOCUMENTS

There are five tag-out documents that you may use in your job as a Fire Controlman:

- Tag-out logs

- CAUTION Tags (NAVSHIPS 9890/5)

- DANGER Tags (NAVSHIPS 9890/8)

- OUT-OF-CALIBRATION Labels (NAVSEA 9210/6)

- OUT-OF-COMMISSION Labels (NAVSHIPS 9890/7)

This subsection discusses the first three documents in depth. The last two documents are labels that are only used to identify test equipment that is either out of calibration or out of commission, and, therefore, need no further explanation.

Tag-Out Log

A tag-out log is a permanent log of the authorizations given for all tag-out actions. Preferably kept in a three-ring binder, it has the following five sections:

SECTION 1. Section 1 contains a copy of the *Equipment Tag-Out Bill,* found in *Standard Organization and Regulations of the U.S. Navy,* OPNAVINST 3120.32; and a copy of the command's amplifying instruction on equipment tag-out procedures.

SECTION 2. Section 2 contains the DANGER/CAUTION Tag-Out Index and Record of Audits (OPNAV 3120/4). The authorizing officer uses this form to assign and track all of the issued DANGER/CAUTION tags. Table 3-7 describes blocks 1 through 5 on figure 3-3.

SECTION 3. Section 3 contains the DANGER/CAUTION Tag-Out Record Sheets (NAVSEA 9210/9) that are still in effect. Figures 3-4 and 3-5 show the front and back sides of this form.

SECTION 4. Section 4 contains the Instrument Log (NAVSHIPS 9890/10). Keep a record of all the OUT-OF-COMMISSION and OUT-OF-CALIBRATION labels issued in this log.

SECTION 5. Section 5 contains the DANGER/CAUTION Tag-Out Record Sheet (NAVSEA 9210/9). Keep the record sheets that have been cleared and are no longer in effect in this section.

DANGER/CAUTION TAG-OUT INDEX AND RECORD OF AUDITS

1. LOG SERIAL	2. DATE ISSUED	3. TYPE (DANGER/CAUTION)	4. DESCRIPTION (SYSTEM, COMPONENT, WORK PERMIT OR TEST DOCUMENT REFERENCE)	5. DATE ISSUED

OPNAV3120/4 (Rev. 3/93)

FCf03003

Figure 3-3.—DANGER/CAUTION Tag-Out Index and Record of Audits (OPNAV 3120/4).

CAUTION Tag

A CAUTION Tag (NAVSHIPS 9890/5) is a YELLOW tag, shown in figure 3-6. It is used only as a precautionary measure to give temporary special instructions or to indicate that anyone operating the equipment to which the tag is attached must exercise unusual caution. The instructions you write on the CAUTION tag must state the specific reason why you attached the tag.

Do not use a CAUTION tag if there is a chance someone could be hurt or if equipment could be

Table 3-7.—DANGER/CAUTION Tag-Out Index and Record of Audits Description

Block	TITLE	Description
1	Log Serial	The sequential log serial number issued for tag-out actions.
2	Date Issued	The date the log serial number was issued.
3	Type	The type of tags used, either CAUTION or DANGER.
4	Description	The description of the system or component that will be tagged out and any amplifying information.
5	Date Issued/Cleared	The date that ALL the tags were cleared.

damaged when normal operating procedures are used. In that case, use a DANGER tag.

DANGER Tag

A DANGER Tag (9890/8) is a RED tag, shown in figure 3-7. It is used to prohibit operation of equipment that, if operated, could jeopardize the safety of personnel or damage the equipment. Under NO circumstances may equipment be operated or removed when it is tagged with a DANGER tag.

TAG-OUT PROCEDURES

Before you tag out a piece of equipment, be sure that you have your supervisor's permission. If the equipment is mission-critical, you may also need permission from your division officer or department head.

For further information on equipment tag-out procedures, refer to the *Tag-out User's Manual,* NAVSEA S0400-AD-URM-010/TUM.

Q7. What three situations discussed in the text require you to tag out equipment?

Q8. Name two tagout responsibilities of your department authorizing officer for tag out procedures.

Q9. What are the five tag-out documents that you may use in your job as a Fire Controlman?

PROTECTIVE EQUIPMENT

The wearing of the correct protective equipment is essential to all naval personnel. It is especially important for the safety of electronics personnel. This section discusses basic electrical equipment: safety shoes; rubber gloves; safety shorting probes; eye, hearing, and respiratory protection; and deck-insulating material.

ELECTRICAL SAFETY SHOES

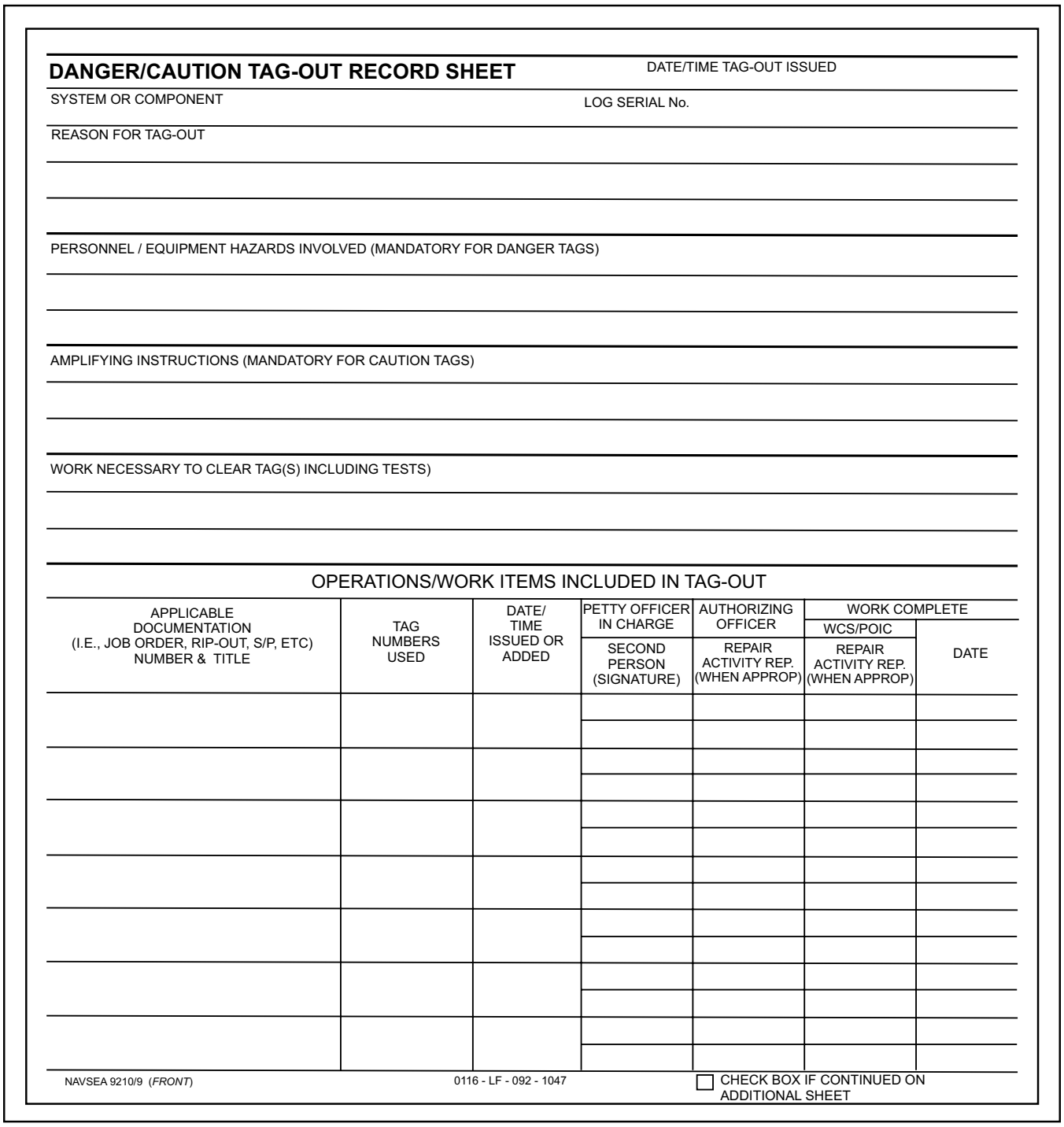
You will normally be issued a pair of electrical safety shoes when you report to your first duty station. You must wear them whenever you work on or around energized equipment. Take care of them. You can clean and shine them just like regular safety shoes. When they become worn out or damaged, turn them in to your supply division for a new pair. Electrical safety shoes do not have any exposed metal parts like you might find on regular safety shoes. They have special non-conducting soles designed to protect you from a maximum of 600 volts.

RUBBER GLOVES

Rubber gloves are designed to keep you from being injured when you must or may accidentally touch an electrically "live" component. There are four classes of rubber insulating gloves. The primary features of the gloves are their wall thickness and their maximum safe voltage rating. Refer back to table 3-3 for glove classes and the maximum safe voltage for which they may be used.

SAFETY SHORTING PROBE

Some of the electronic equipment you may work on will use large capacitors to filter the electrical power. You must discharge these capacitors before working on the equipment by using a safety shorting probe. The procedure for using a shorting probe is provided in table 3-8.



DANGER/CAUTION TAG-OUT RECORD SHEET

DATE/TIME TAG-OUT ISSUED

SYSTEM OR COMPONENT

LOG SERIAL No.

REASON FOR TAG-OUT

PERSONNEL / EQUIPMENT HAZARDS INVOLVED (MANDATORY FOR DANGER TAGS)

AMPLIFYING INSTRUCTIONS (MANDATORY FOR CAUTION TAGS)

WORK NECESSARY TO CLEAR TAG(S) INCLUDING TESTS)

OPERATIONS/WORK ITEMS INCLUDED IN TAG-OUT

APPLICABLE DOCUMENTATION (I.E., JOB ORDER, RIP-OUT, S/P, ETC) NUMBER & TITLE	TAG NUMBERS USED	DATE/ TIME ISSUED OR ADDED	PETTY OFFICER IN CHARGE / SECOND PERSON (SIGNATURE)	AUTHORIZING OFFICER / REPAIR ACTIVITY REP. (WHEN APPROP)	WORK COMPLETE: WCS/POIC / REPAIR ACTIVITY REP. (WHEN APPROP)	WORK COMPLETE: DATE

NAVSEA 9210/9 (*FRONT*) 0116 - LF - 092 - 1047 ☐ CHECK BOX IF CONTINUED ON ADDITIONAL SHEET

FCf03004

Figure 3-4.—DANGER/CAUTION Tag-Out Record Sheet (NAVSEA 9210/9)(front).

EYE PROTECTION

No matter what job you are performing, you depend heavily on your sense of sight. To help protect your eyesight, you should know when to wear eye protection and what eye protection to wear. The *Navy Occupational Safety and Health (NAVOSH) Program Manual,* OPNAVINST 5100.23, states that you must wear appropriate eye protective equipment whenever you perform eye-hazardous operations. In other words, whenever you are doing something that could damage your eyes, wear eye protection.

Some of the things you may do that fall into the eye-hazardous category are:

- soldering,

TAG Number	LOCATION	TAGGED POSITION CONDITION	POSTED BY (INITIAL)	POSTING CHECKED BY (INITIAL)	CLEARANCE POSITION/ CONDITION	CLEARANCE AUTHORIZED (SIGNATURE)		DATE/ TIME CLEARED	CLEARED BY (INITIAL)
						AUTHORIZING OFFICER	REPAIR ACTIVITY		
SIGNATURE OF WATCH OFFICER / DUTY OFFICER					DATE/TIME		☐ CONTINUED ON ADDITIONAL SHEET (CHECK IF APPLICABLE)		

NAVSEA 9210/9 (*BACK*) 0116 - LF - 092 - 1047

FCf03005

Figure 3-5.—DANGER/CAUTION Tag-Out Record Sheet (NAVSEA 9210/9)(back).

- using an electric drill,
- maintaining batteries, and
- cleaning and maintaining equipment by using hazardous materials.

You should remember the following facts regarding eye protection:

- Eye protection is not an option; it is a requirement. If you are doing something that calls for eye protection, take the time to get it and wear it. You can replace a scratched pair of goggles, but you cannot replace a scratched eye.
- Wear eye protection even when you are just "walking around" hazardous activities.

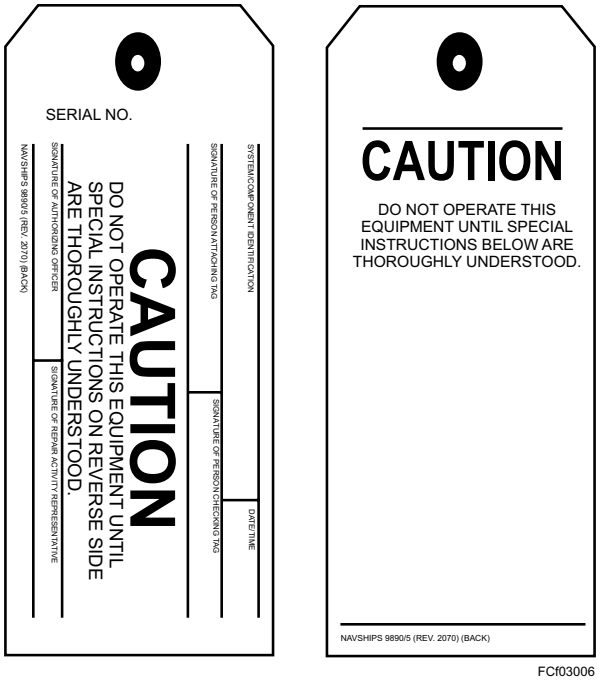


Figure 3-6.—CAUTION Tag (NAVSHIPS 9890/5).

- Clean and store eye-protection equipment properly after you are through using it.

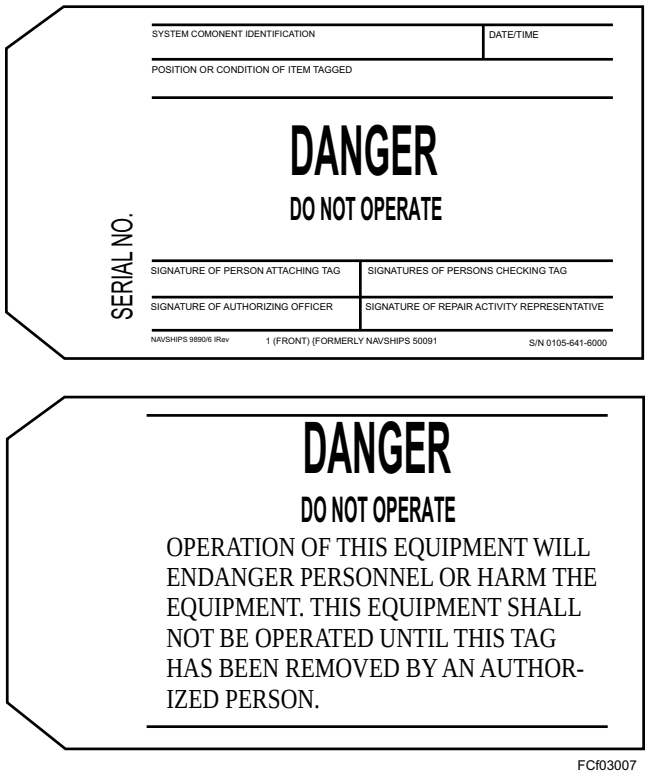


Figure 3-7.—DANGER Tag (NAVSHIPS 9890/8).

HEARING PROTECTION

Although you may not think of hearing protection as being associated with electrical and electronic repair, it is. Consider the area in which you will be working. Hearing loss is a problem in the Navy. Every day, you may be working with and around noisy equipment and machinery that could damage your hearing. In most cases, the damage will not happen overnight; it will happen slowly.

Your hearing may degrade until you will not be able to hear the softer sounds as well as you could have if you had worn hearing protection. This is commonly called a *hearing threshold shift.* It simply means that the more you are exposed to damaging levels of noise, the louder normal sounds must be for you to hear them.

You must start now to protect yourself from hearing loss. OPNAVINST 5100.23 states that all personnel must wear hearing protective devices when they enter or work in an area where the operations generate noise levels of greater than 84 decibels. If you are in doubt about whether a noise level is high enough

Table 3-8.—Safety Shorting Probe Procedure

Step	Action(s)
1	Secure the input power to the equipment. Use appropriate tag-out procedures, if necessary.
2	Open the equipment to gain access to the capacitors that need to be discharged. Do NOT touch any exposed terminals, as large filter capacitors can store a lot of energy.
3	Connect the flexible ground strap of the safety shorting probe to the metal chassis of the equipment, ensuring a good metal-to-metal connection.
4	Hold the safety shorting probe by its plastic handle and touch the metal probe tip to the appropriate terminals to be grounded. Do NOT touch the metal probe tip or the flexible ground strap while the probe is in contact with the capacitor's terminals. Repeat this step two or three times to ensure that the capacitor is completely discharged.

to require hearing protection, err toward the side of safety. Protect your hearing!

RESPIRATORY PROTECTION

It is very important to use the proper respiratory protection when you use hazardous paints, solvents, and other materials associated with cleaning and maintaining electronic equipment and antennas. Be sure to ask your supervisor about the need for respiratory protection whenever you

- chip lead- or chromate-based paints while removing corrosion,
- prime or paint the bases of antennas, or
- clean circuits with spray solvents or alcohol.

Whenever you perform these operations, be sure that the work area has good ventilation. This will help prevent you from over-inhaling hazardous vapors and dusts.

DECK-INSULATING MATERIAL

Your working environment should have deck-insulating material (more commonly called rubber matting) to protect you and your shipmates from electric shock. It must be installed wherever work is done on energized electrical and electronic equipment. This includes electronic repair shops that have workbenches for working on electronic equipment.

The rubber matting should be rated for use in areas where the maximum voltage will not exceed 3,000 volts. It must be installed in one continuous run, at least 36 inches wide, and must extend at least 24 inches past each end of the workbench.

If you must work on energized equipment in an area where rubber matting is not installed, protect yourself from electric shock by using a 6-foot piece of rubber matting as a portable safety deck. When you are done, roll it up and store it for the next job.

Rubber matting does a great job of protecting you from electric shock, but it will not protect you for long if you do not take care of it.

The following tips will help keep the insulating properties of rubber matting intact:

- Keep rubber matting clean and free of any excess dirt, oil, or oil-based products. When you clean it, do NOT use abrasive cleaners or electric buffers; they will ruin its insulating effectiveness.
- Inspect the rubber matting for cuts, cracks, or excessive wear periodically. If you notice any of these conditions, replace it entirely.

Q10. Name four types of personal protective equipment associated with working with electricity.

SUMMARY

Throughout your training you have been taught about electrical and electronic safety. This chapter has attempted to give you an overview of this area of safety. However, one of the greatest dangers in this area is not your lack of knowledge but the complacency you may develop from hearing the same message over and over. You know these safety standards; they have been drilled into your thinking. You may have even taught this material to someone at some time in your career. DO NOT ALLOW A COMPLACENT ATTITUDE TO KILL YOU! Although voltage is normally mentioned in talks about electrical shock, you must remember that current is what will kill you. As little as one-tenth of one ampere (0.1 ampere) of current can be fatal. The majority of shock fatalities are related to voltages less than 120 volts. Even lesser voltages can be fatal because of the relative current flow. Treat all voltages as life threatening.

In view of the potential harm of electrical shock, the tag-out system was implemented for your safety. Do not take anything for granted when tagging out equipment. Make sure everything is done by the book and that you and your fellow FC's are safe. Do not be in such a hurry that you use short cuts in tagging equipment out or in using protective equipment. Do not adopt the attitude that it's "the other guy" who gets killed or injured when using "short cuts." **Read**, **study**, and **know** what your command requirements are for tagging out equipment and checking out protective gear.

Take the knowledge offered in this chapter and apply it to your everyday job.

Remember, SAFETY FIRST!

ANSWERS TO CHAPTER QUESTIONS

A1. The amount of body resistance you have to the current flow, the path the current takes through your body, and the length of time the current flows through your body.

A2. Isolate, insulate, and ground.

A3. ALWAYS notify and obtain permission from your commanding officer (afloat) or your supervisor (ashore) to work on energized equipment. (Some commands require you to complete a checklist before doing this.)

A4. When your measuring a voltage above 300 volts, you must NOT hold the test probe while the equipment is energized. Instead, you must attach the test probes while the equipment is de-energized.

A5. Electrostatic discharge (ESD).

A6. A microwave oven. RF injuries result from the tissue being "cooked" in a manner similar to the way food is cooked in a microwave oven.

A7. Working aloft or over the side, doing corrective or preventive maintenance.

A8. Ensure that personnel are qualified to do the work they are about to do, maintain tag-out logs, signing and issuing tags and tag-out record sheets, clear the record sheets from the tag-out logs, and destroying the tags when the work is completed.

A9. Tag-out logs, CAUTION Tags (NAVSHIPS 9890/5), DANGER Tags (NAVSHIPS 9890/8), OUT-OF-CALIBRATION Labels (NAVSEA 9210/6), and OUT-OF-COMMISSION Labels (NAVSHIPS 9890/7).

A10. Safety shoes, rubber gloves, safety shorting probes, eye protection, hearing protection, respiratory protection, and deck-insulating material.